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Five New Species of *Plagiostachys* (Zingiberaceae) from Borneo

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Five new species of the genus *Plagiostachys* (Zingiberaceae) from Borneo, *P. brevicalcarata*, *P. longicaudata*, *P. megacarpa*, *P. roseiflora*, and *P. viridisepala* are described and illustrated. Of these, *P. brevicalcarata*, *P. longicaudata*, and *P. viridisepala* have mucilaginous inflorescences, while the inflorescences of the other two species are non-mucilaginous. A key to the Bornean species of *Plagiostachys* is also provided.

Key words: Borneo, *Plagiostachys brevicalcarata*, *Plagiostachys longicaudata*, *Plagiostachys megacarpa*, *Plagiostachys roseiflora*, *Plagiostachys viridisepala*, Sabah, Zingiberaceae

The genus *Plagiostachys* Ridl. (Zingiberaceae) is rather small in the family, comprising about 20 species (Larsen *et al.* 1998), and is distributed from Indochina to Malesia with the center of diversity in Borneo. *Plagiostachys* is characterized by the inflorescences that emerges laterally from the leafy shoot, either in the middle or at one-third distance from the base, or occasionally just above ground level (Ridley 1899, Smith 1990). The inflorescence is tightly congested and occasionally bears up to nine branches, either from the base or on the main axis. The bracts are absent or rudimentary, and the bracteoles are generally tubular, each subtending a single flower (Larsen *et al.* 1998). Certain species are mucilaginous because the fleshy flowers tend to decay within one day. This often makes it difficult to examine herbarium material, since the floral structure can be lost.

The existing classification of the Bornean species of *Plagiostachys* is based on the eminent work of Smith (1985). She divided the genus into two groups, Group I and Group II, based mainly on the mucilaginous versus non-mucilaginous nature of the inflorescence. Group I is characterized by having a mucilaginous inflorescence, a bilobed ligule, tubular bracteoles that soon decay and leave only the basal part, yellow and white flowers with some pink on the labellum, a fleshy calyx disintegrating at least in the upper part, a style that is sometimes connate with the corolla wall above the epigynous glands, and an oblong-pyriform or, rarely, globose capsule. The species belong to Group II are characterized by their non-mucilaginous inflorescences. In addition, the ligule is truncate or emarginate and rarely bilobed, the bracteoles are tubular at the base or open and partially decay or persist, the flowers are pinkish red with a yellow labellum, the style is usually free from the corolla wall at the base, and the capsule is globose.

These groupings, however, cannot be used since the discovery of several new species described in the last few years by Cowley (1999), Sakai & Nagamasu (2003), and Gobilik *et al.* (2005). The characters of the bracteole, ligule, flower and labellum color, style, and capsule of these species do not fit with Smith's grouping. For instance, the style adnate to the corolla wall above the epigynous glands, which is supposed to be characteristic of Smith's Group I, is also observed in many non-mucilaginous species (Smith's Group II), for example in *P. parva* J. Cowley, *P. breviramosa* J. Cowley, *P. lasiophylla* Gobilik & A. L. Lamb and *P. oblanceolata* Gobilik & A. L. Lamb. The five new species presented here also belong to neither of Smith's two groups.

Based on our field and herbarium studies, we noticed that the presence of an anther crest, the coloration and hairiness of the capsule, and the adnation of the style to the corolla wall can be used as rather stable and significant characters to differentiate between closely related species. Using these features, there is justification to recognize five new species.

Materials and Methods

Observations of morphological characters in living plants in the field and on herbarium sheets were conducted. Most of the data on the inflorescences and flowers, which are not observable in dried specimens, were recorded in the field. Fresh flowers and fruits were preserved in 70% ethanol for further examination in the laboratory. Both dried and spirit preserved specimens were deposited at BORH and HYO. Additional materials were examined at BO, BORH, E, K, SAN, SAR and SNP.

1. **Plagiostachys brevicalcarata** A. Julius & A. Takano, **sp. nov.** (Figs. 1, 6A, B, C)

Haec species nova *Plagiostachydi glandulosae* S. Sakai & Nagam. inflorescentia mucilaginea, labello spathulato, filamento glandulifero et pubescenti similis, sed foliis superus pagina glabris, calycibus cucullatus, et antherae crista biloba distinguenda.

Typus. MALAYSIA. Sabah: Papar District, Crocker Range Park, Ulu Kimanis, Trail 4, 30 March 2004, *A. Julius 155* (holo- SAN; iso- HYO).

Perennial herbs. Stems leafy, c. 230 cm tall, in large clumps, crowded. Leaves c. 6 pairs per shoot; petiole 7-11(-20) mm long, pubescent; lamina c. 110 cm long, 16 cm wide, broadly elliptic, base cuneate, undulate, apex long acuminate, acumen c. 3 cm long; upper surface glabrous; lower surface densely pubescent; ligule 5-10 mm long, bilobed, apex rounded, pubescent with short scattered hairs; sheath finely reticulate, glabrous. Inflorescence borne 23-30 cm above ground, 6-11 cm long, longer in fruit, mucilaginous, branched at base; branches 3(-5), lateral branches shorter than terminal one; bracts 3; bracteoles tubular, 1.7-2.8 cm long, long apiculate, c. 7 mm long after partially decaying and only apical tip and veins remaining above tube, basal part persistent at fruiting stage, inner surface glabrous, outside velvety. Flowers 15-23 mm long; corolla pink, translucent; calyx hooded, 9-14 mm long, trilobed, lobes thick, fleshy, spurred, upper part decaying leaving only veins above tube; corolla tube c. 7 mm long, glabrous except for scattered hairs near apex; dorsal petal elliptic, c. 9 mm long, c. 5 mm wide, hooded, apex acute and with few tufted hairs; lateral petals c. 6 mm long, c. 4 mm wide, elliptic; labellum yellow, thick, centrally grooved, c. 7 mm long, c. 6 mm wide, spatulate, bilobed, lobes c. 2 mm long, apex acute; labellum throat conspicuous, c. 2 mm long; lateral staminodes longer than filament, c. 3 mm long, c. 1 mm wide, narrowly oblong, base swollen, apex acute, covered with glandular projections and short bristle-like hairs in central part, curved outwards; anthers 3.5-3.6 mm long, 2.5 mm wide, with conspicuous densely covered with glandular hairs, setulose; anther crest 0.5-1.5 mm long, bilobed, apex acuminate; filaments c.

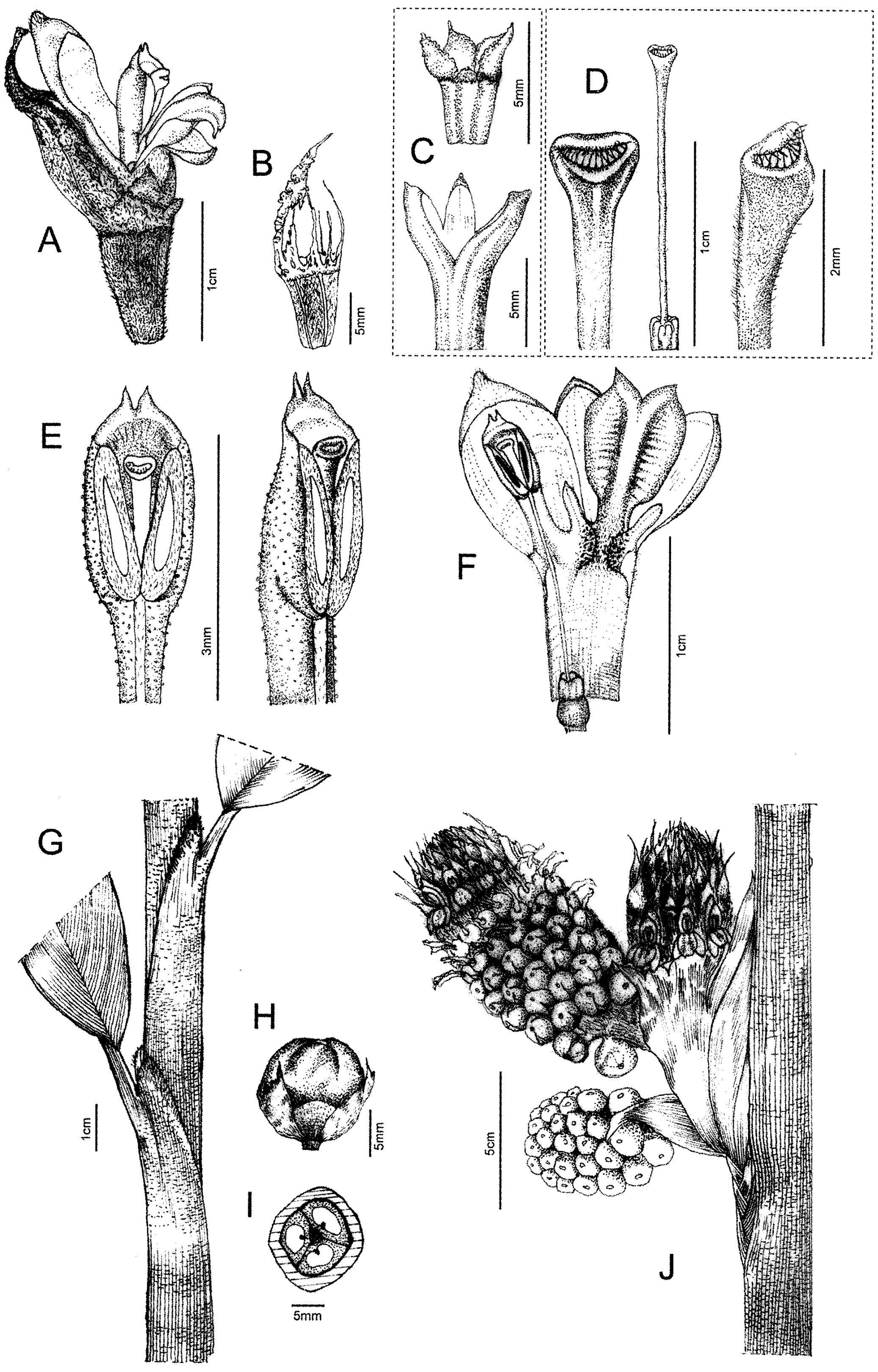

FIG. 1. *Plagiostachys brevicalcarata* A. Julius & A. Takano. A: Flower. B: Bracteole. C: Calyx, decaying in upper part (upper) and before decaying (lower). D: Stigma, close-up (left); Stigma, style, and epigynous glands (center); Stigma, profile view (right). E: Lateral (right) and front (left) views of anther and anther crest. F: Dissected flower. G: Ligule and petiole. H: Capsule. I: Cross section of capsule. J: Inflorescence and infructescence. (Drawn by Jusimin Duaneh).

2 mm long, c. 1 mm wide; style 11-14 mm long, pubescent with long hairs, adnate to corolla wall for 2 mm above epigynous glands; stigma 0.7-1 mm wide, apex rounded, mouth of dorsal opening ciliate with short tufted hairs; epigynous glands c. 1 mm long, 1 mm wide; ovary c. 3 mm long, glabrous. Capsule c. 1.6 cm long, 1.5 cm wide, globose to obovoid, glabrous, dark purple or dull red when immature, turning dark green at maturity, firm, shiny.

Distribution. Borneo (Sabah, Sarawak, and C Kalimantan)

Habitat. Plagiostachys brevicalcarata is abundant on slopes and forest floors in shady areas of primary hill forests and in secondary forests. Occasionally it is found near streams and in wet areas.

Etymology. Plagiostachys brevicalcarata is named for the short spur at the apex of the calyx.

Vernacular name. Munong babi (Iban).

Notes. Plagiostachys brevicalcarata shows wide variation in the hairiness of the leaves and the color of the fruits. The glabrous fruits are red when young, but the dried, wrinkled specimens are dark to light brown.

Affinity. Plagiostachys brevicalcarata has an affinity with *P. glandulosa*, but differs from the latter species in the following characters: lamina elliptic, upper surface glabrous, base cuneate, apex long acuminate; petioles hairy; calyx hooded; anthers crested; lateral staminodes narrowly oblong, swollen at base, covered with glandular projections and short bristle-like hairs.

Specimens examined. MALAYSIA. **Sabah:** Keningau District: Ulu Senagang, *R. Repin et al. SP09880* (SNP). Papar District: Crocker Range Park, Ulu Kimanis, Trail 4, *A. Julius & A. Takano AT11* (BORH, SNP), *ibidem*, *A. Julius & A. Takano AT35* (BORH, SNP); Limpaga River, Ulu Kimanis, *D. Sumbin et al. SP 17384* (SNP); Kawang Forest Reserve, Sg. Mook, heavily disturbed forest, formerly a burned forest, *J. Gobilik 813* (SAN). Ranau District: Kinabalu Park, Melangkap Tomis, primary forest, *L. Lugas 727* (SNP), *ibidem*, *L. Lugas 1209* (SNP). **Sarawak:** Marudi, Sg. Silat Basin, upstream of Sg. Palutan, near stream on slope 2°49.10'N 114°59.09'E, 500 m alt., *Sam et al. S.91691* (SAR); Gunung Mulu National Park, in vicinity of base camp, near bank of stream in lower montane forest, 200 m alt., *M. C. Warwick & C. Jeremy MW 143* (E); Sg. Berangan, Btg. Dalui Bakun HEP, Ulu Sg. Belaga, logged over, M. D. Forest, 470 m alt., *Lai et al. S.71116* (SAR); 1st Division, Semengoh Forest Reserve, *B. L. Burtt & A. M. Martin B4718* (E).

INDONESIA. **Central Kalimantan:** Headquarters of Sg. Kahayan, 5 km NE of Haruwu Village, old secondary forest, common, wet and shaded places near ditch, 0°28'S 113°44'E, 200 m alt., *Hewitt series 141* (SAR).

2. Plagiostachys longicaudata A. Julius & A. Takano, sp. nov. (Figs. 2, 6D, E, F)

Haec species *Plagiostachydi brevicalcaratae* A. Julius & A. Takano affinis, sed antheris cristatis trilobis et capsulis bicoloribus differt; vegetative *Plagiostachydi glandulosae* similis, sed antheris cristatis et staminodiis ellipticis distinguenda.

Typus. MALAYSIA. Sabah: Lahad Datu District, Danum Valley Conservation Area, Tembaling Trail, mixed lowland dipterocarp forest, with shaded and surrounding areas, 17 Feb. 2004, *A. Julius & A. Takano AT76* (holo-SAN; iso- HYO).

Perennial herbs. Stems leafy, c. 110 cm tall. Leaves 5-11 pairs per shoot; petiole 1.5-3 cm long; lamina 20-40 cm long, 4.5-14 cm wide, elliptic, base cuneate, apex long caudate, acumen c. 4 cm long, both surfaces pubescent; lower surface with longer and denser hairs; ligule 0.5-1 cm long, bilobed to base, apex obtuse, ciliate, densely long hairy, striate; sheath striate, with scattered hairs. Inflorescence borne to 10 cm above ground, sometimes emerging at ground level, 1.5-6 cm long, sometimes longer in fruit, mucilaginous, normally unbranched, if branched the branches 2 or 3 at base; bracts 2, margins red, ciliate; bracteoles tubular 0.5-1.4 cm long, upper part soon decaying and leaving only veins, inside glabrous, outside pubescent, with dense straw colored hairs along keel and at base, translucent, tinted maroon. Flowers c. 16 mm long; calyx 5-10 mm long, 5 mm wide, trilobed, apex acute, disinte-

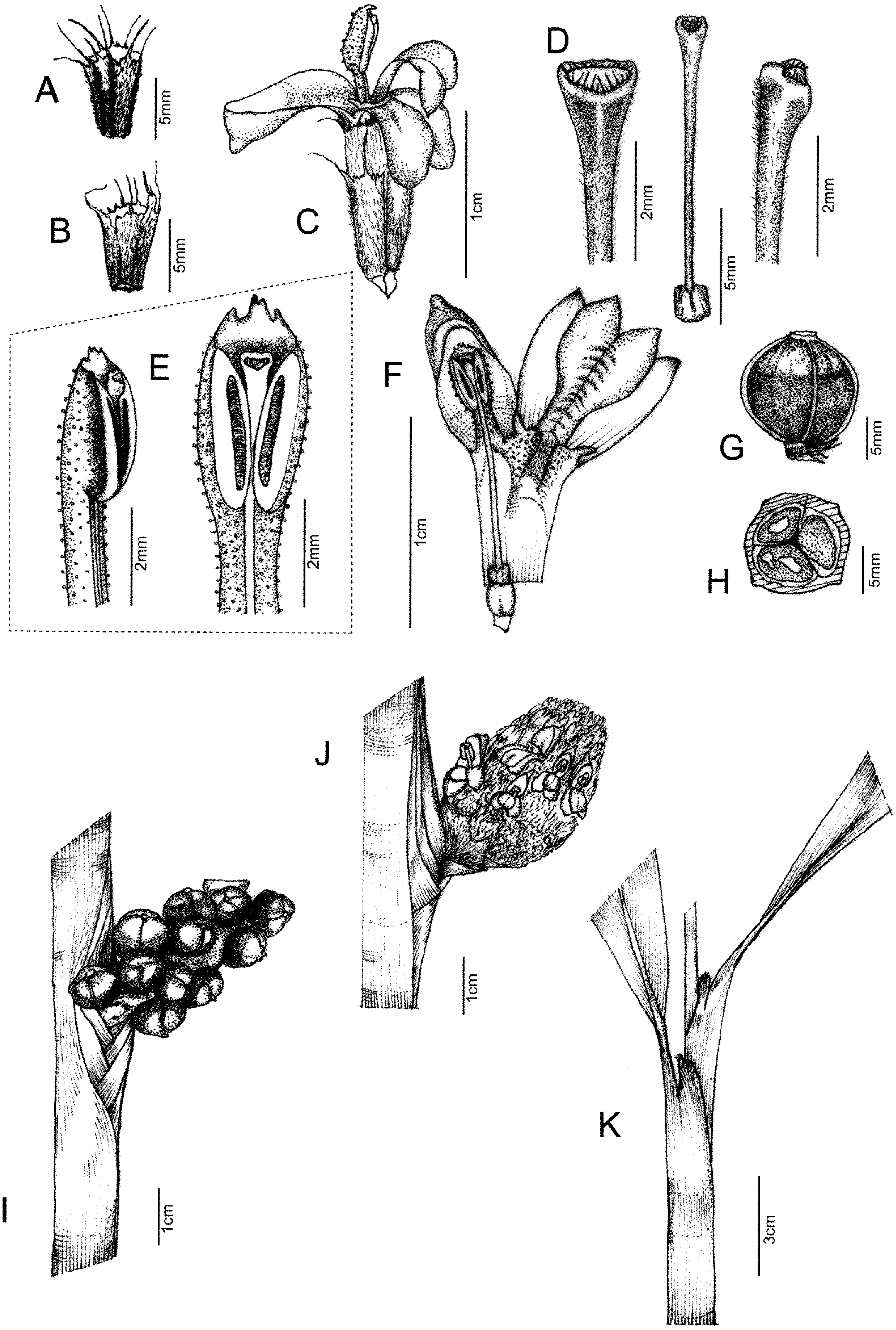

FIG. 2. *Plagiostachys longicaudata* A. Julius & A. Takano. A: Bracteole. B: Calyx. C: Flower. D: Stigma, close-up (left); Stigma, style, and epigynous glands (center); Stigma, profile view (right). E: Lateral (left) and front (right) views of anther. F: Dissected flower. G: Capsule. H: Cross section of capsule. I: Infructescence. J: Inflorescence. K: Ligule and petiole. (Drawn by Jusimin Duaneh).

grating at anthesis to leave only veins remaining above the tube, both surfaces glabrous, lower part translucent with deep purple blotches; corolla tube 5-7 mm long, both surfaces glabrous; dorsal petal c. 9 mm long, 5 mm wide, ovate, hooded, with shortly obtuse spur, translucent, deep purple, inside with some purple blotches in lines, both surfaces glabrous, ciliate; lateral petals 6-7 mm long, 4 mm wide, elliptic, outside pubescent, inside glabrous, margins ciliate near apex, apex translucent with purple blotches; labellum yellow, thick, c. 8.5 mm long, throat of labellum conspicuous, 2-3.5 mm long, 2 mm wide, spatulate, bilobed, lobes c. 4 mm long, apex acute, curved downwards, margins on lower surface covered with glandular hairs, upper surface at base of labellum throat pubescent; lateral staminodes elliptic, c. 2 mm long, 0.8 mm wide, curved outwards, with swelling at base, covered with glandular hairs, swollen part shaggy; anthers 2-3 mm long, 2 mm wide, covered with glandular hairs; anther crest 0.5-1 mm long, trilobed; filament narrow, c. 2 mm long, 1 mm wide, covered with glandular hairs; style c. 1.2 cm long, sparsely pubescent, adnate to corolla tube for 1-3 mm above epigynous glands; stigma c. 1 mm wide, apex rounded, dorsal opening long ciliate, cilia around mouth erect; epigynous glands c. 1.2 mm long, 1.2 mm wide, cylindrical; ovary c. 2.5 mm long, 1.2 mm wide, glabrous. Capsule c. 1.5 cm long, 1 cm wide, globose or ellipsoid, apex crowned with short calyx base, glabrous, bicolored, basal part pale green, apex light purple when immature, base turning green and apex turning dark purple at maturity.

Distribution. Borneo (Sabah and W Kalimantan).

Habitat. Cool, shady, mossy places in mixed lowland dipterocarp forests.

Etymology. The specific epithet of *Plagiostachys longicaudata* refers to the distinct, long caudate leaf apex.

Affinity. This mucilaginous species is most closely related to *P. brevicalcarata*, but differs in certain respects, such as in its long caudate leaf apex, sparsely pubescent leaf sheath, bracteole not long-apiculate, elliptic lateral staminodes, trilobed anther crest, and bicolored capsule. Vegetatively, *P. longicaudata* resembles *P. glandulosa*, but the former possesses an anther crest and elliptic lateral staminodes, as opposed to the ecristate anthers and triangular lateral staminodes in the latter species.

Specimens examined. MALAYSIA. **Sabah:** Lahad Datu District: Danum Valley Conservation Area, West 9, near trail, *A. Julius & J. Gisil 8* (BORH); Nature Trail, 4°40'N, 117°29'E, 150 m alt., *D. Magintan 520* (BORH, SAN); East Trail, *E. J. F. Campbell SAN112191* (E).

INDONESIA. **West Kalimantan:** Ketapang, Gunung Palung National Park, Sungai Air Putih, along stream through freshwater swamp forest, 10 m alt., *Laman et al. TL 332* (E).

3. **Plagiostachys megacarpa** A. Julius & A. Takano, **sp. nov.** (Figs. 3 & 7A, B)

Herba usque 3 m alta, *Plagiostachydi crocydocalyci* (K. Schum.) B. L. Burtt & R. M. Sm. inflorescentia usque 25 cm longa aliquam similis, sed inflorescentia non myxogena differt; capsulis rotundatis et pubescentibus *P. strobiliferae* Ridl. similis, sed capsulis majoribus usque 3.5 cm longis, antherae crista acuta, staminodiis oblongis vel late ellipticis distinguenda.

Typus. MALAYSIA. Sabah: Papar District, Crocker Range Park, Ulu Kimanis, Trail 4, near boundary, on forest floor, 28 June 2004, *A. Julius, Gusili & Sabilin 2* (holo- SAN; iso- HYO).

Perennial herbs. Stems leafy, c. 2.5 (-3) m tall, crowded. Leaves 4-9 pairs per shoot; lamina (23-) 66-78 (-85) cm long, 9-10 (-13) cm wide, elliptic to oblanceolate, base cuneate, apex acuminate, acumen 1.5-2.5 cm long, dark green except midrib pale green, upper surface glabrous, lower surface velvety; petiole 0-1.5 cm long, swollen at base; ligule bilobed, c. 7 mm long, apex acute or rounded, ciliate, pubescent, red; sheath reticulate; bladeless sheaths 3, apex truncate. Inflorescence borne 25-150 cm above ground, 6-13 cm long, fusiform, non-mucilaginous, longer in fruit, to 21 cm long, oblong,

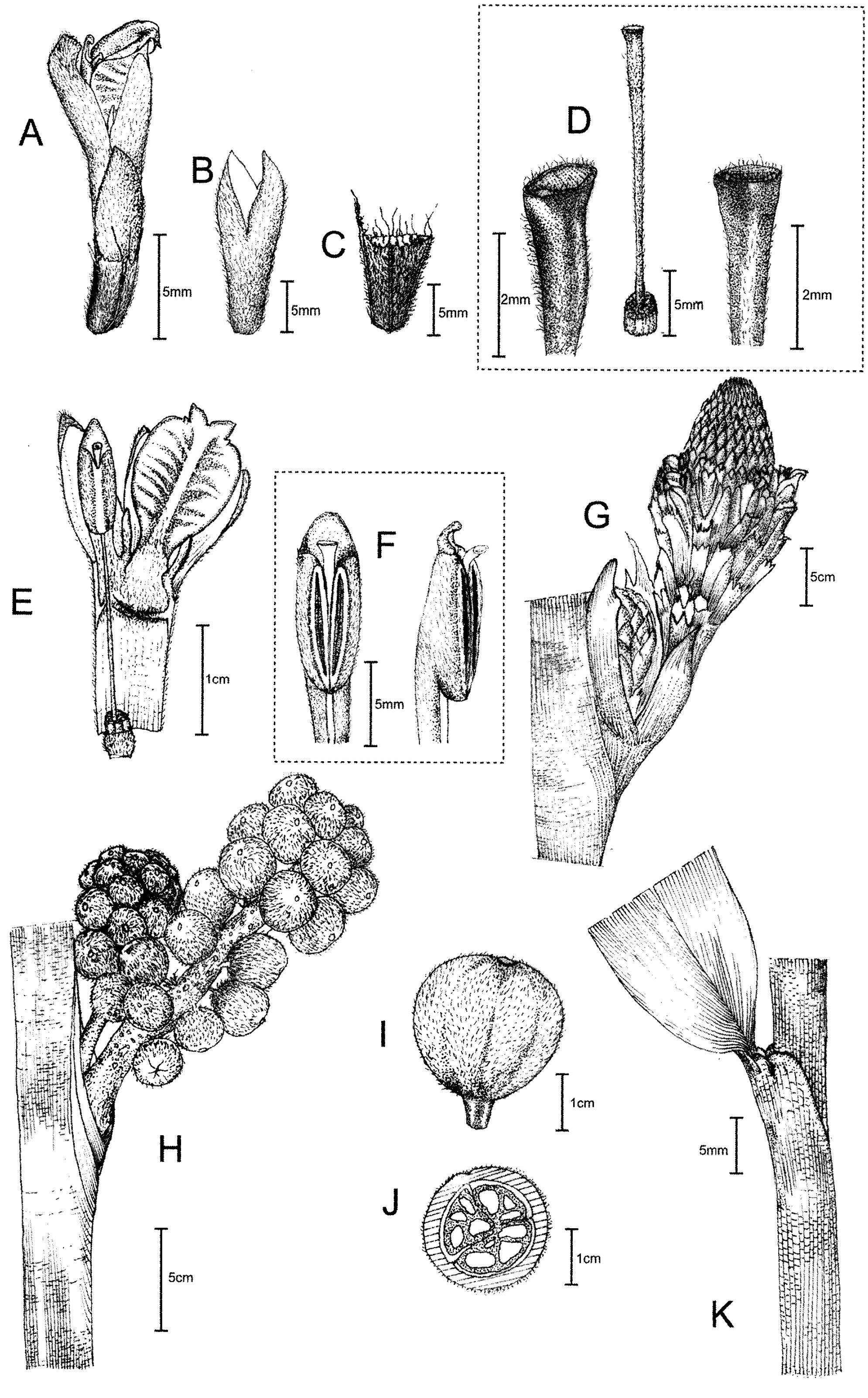

FIG. 3. *Plagiostachys megacarpa* A. Julius & A. Takano. A: Flower. B: Calyx. C: Bracteole. D: Stigma, profile view (left); Stigma, style, and epigynous glands (center); Stigma, close-up (right). E: Dissected flower. F: Lateral (right) and front (left) views of anther and anther crest. G: Inflorescence. H: Infructescence. I: Capsule. J: Cross section of capsule. K: Ligule. (Drawn by Jusimin Duaneh).

branches 2 rarely 3 or unbranched, pedunculate, peduncle 4-10 cm long; bracts 2 or 3; bracteole tubular, c. 13 mm long, thin, partially decaying before anthesis leaving only veins above tube, with dense straw colored hairs. Flowers 3.2-3.5 cm long, pink or orangish pink when fresh, turning pale purplish pink or black when decayed; calyx membranous, dorsally fissured for c. 10 mm, outside pubescent with dense longer hairs near apex, apex bilobed; corolla tube 1.5-1.7 cm long, both surfaces pubescent, inner surface with scattered hairs near apex; dorsal petal elliptic, c. 12 mm long, c. 5 mm wide, hooded, pubescent with long densely tufted hairs at apex; lateral petals elliptic, c. 10 mm long, c. 4 mm wide, outside covered with scattered hairs, margin with few hairs; labellum obovate, 12 (-19) mm long, 9 mm wide, upper surface pubescent at base, rose pink with an orange tip, margin with scarlet transverse lines; lateral staminodes linear, (2-) 5 mm long, (0.7-) 0.8 mm wide, apex acute or obtuse, usually longer than filament, both surfaces sparsely hairy near base; anthers c. 8 mm long, c. 3 mm wide, oblong, whitish or pale pink, covered with short hairs, more densely so on thecae; anther crest c. 3 mm long, c. 2.5 mm wide, entire, apex obtuse; filament short, c. 2 mm long; style c. 19 mm long, densely hairy, free from corolla wall; stigma 1-1.2 mm wide, apex flat, with dorsal opening, mouth ciliate with tufted hairs; epigynous glands c. 3 mm long; ovary c. 3 mm long, densely hairy. Capsule (1.5-) 2.2-3.5 cm long, (1.3-) 2 cm wide, with dense fine hairs, globose; immature fruit green to deep green, becoming dark brown or orangish brown at maturity; pedicels 4-6 mm long.

Distribution. Borneo (Sabah, Sarawak, and E Kalimantan).

Habitat. Cool, shady, mossy places in mixed lowland dipterocarp forests; in primary and old secondary forests and on ridges and slopes.

Etymology. The large capsules, larger than in other members of *Plagiostachys*, are an outstanding characteristic of *P. megacarpa*. The epithet *megacarpa* was chosen to denote this feature.

Vernacular name. Tubu becit (Lundayeh).

Notes. Plagiostachys megacarpa was suspected by Smith (1985), based on a specimen collected by *B. L. Burtt 8137* (E) from Sarawak, to be new. *Plagiostachys megacarpa* differs from Smith's Group II in (1) its bracteole, which is distinctly tubular and disintegrates just before anthesis, and (2) in its bilobed ligule. Most of the living plants and herbarium specimens studied show that the calyx does not persist on the capsule. The inflorescence of *P. megacarpa* normally has two branches, some plants with three branches in bud were seen (*A. Julius 154*, BORH). Only two branches per infructescence, however, are well developed (A. Julius, unpublished data). The capsules of *P. megacarpa* are larger than in other species, become 3.5 cm long and 2 cm wide, with the pedicel 4-6 mm long.

Affinity. Plagiostachys megacarpa resembles *P. crocydocalyx* in its tall leafy stem, but differs from the latter in its non-mucilaginous nature and large capsule. In the pinkish flowers and densely hairy inflorescences, it is similar to *P. strobilifera*, but can be distinguished by its distinctly tubular bracteoles, crested anthers and larger capsules. By the pubescent inflorescence and the color of its flowers, *P. megacarpa* appears to be related to *P. roseiflora*, but the former is much taller and is easily recognized by its large, pubescent capsule.

Specimens examined. MALAYSIA. **Sabah:** Keningau District: Paling-paling Hills, near Senagang, 350 m alt., *A. Lamb & A. Surat ALED 317/91* (E). Kota Marudu District: Bt. Madalong, *Amin et al. SAN109813* (SAN). Papar District: Crocker Range Park, Ulu Kimanis, Trail 4, near boundary, on forest floor where found fallen dead tree with surrounding area, *A. Julius & A. Takano AT16* (BORH), *ibidem*, *A. Julius 154* (BORH). Ranau District: Kinabalu Park - Ulu Nalumad, hill dipterocarp forest, near trail, *A. Julius*, *D. Malidin*, *G. Subilin & M. Gunggutau 2* (BORH, SNP); Poring, Taman Orkid, shaded, near stream, 525 m alt., *H. Ibrahim HI 567* (SNP). Sipitang District: Long Pasia, Tang Faw, at river bank, flooded area, moist, shady, 1030 ft. alt., *A. Julius & A.*

Takano AT311 (BORH, HYO); Long Pasia, secondary forest, *J. Kulip et al. 138733* (SAN); Long Mio-hill across river to E of village, 1000 m alt., *A. Hoare & S. Kapong 114* (SNP); Long Mio - across the river, Surud Nan Mipil Apo, 1 mile to S of village, 950m alt., *A. Hoare & G. Lawa 171* (SNP); Long Pinasat - near Abpa Pulau, 2 miles downriver, 950 m alt., *A. Hoare & P. Labung 203* (SNP); Abpa Leluba - Surud Nan Puput, Hill across river to E of village, *A. Hoare & U. Sudai 288* (SNP); Ulu Padas, swampy, flat area above Sg. Pasia, 4 (25'N 115 (43'E, 1000 m alt., *A. D. Poulsen 1784* (SAN). **Sarawak**: First division, Padawan District, Gunong Manok, *B. L. Burtt 8137* (E).

INDONESIA. **East Kalimantan:** Malinau, Punjungan, Long Belaka (along Lurah River), Kayan Mentarang National Park, 300 m alt., *M. Koizumi 357* (BO).

4. **Plagiostachys roseiflora** A. Julius & A. Takano, **sp. nov.** (Figs. 4 & 7C, D, E)

Plagiostachydi megacarpae similis, sed calycibus trilobis et antherae crista rotunda et retusa, capsulis bicoloribus distinguenda; capsulis rotundatis et pubescentibus, labello subroseo, et in medio pallide flavo *P. strobiliferae* similis, sed bracteola tubulari et fatiscenti ante anthesin, antherae crista rotunda et capsulis globosis differt; floribus subroseis, labello margine crispo, et antheris cristatis *P. oblanceolatae* similis, sed labello subaurantiaco, stylo a tubo corollae libero, foliis oblanceolatis et tubo bracteolae longiore distinguenda.

Typus. MALAYSIA. Sabah: Lahad Datu District, Danum Valley Conservation Area, *A. Julius & B. Ola 4* (holo- SAN; iso- HYO).

Perennial herbs. Stem leafy, 1.5-1.7(-3) m tall. Leaves c. 8 pairs per shoot, sessile or rarely shortly petiolate; petiole to 1.5 cm long; lamina, 32-68.5 cm long, 11-15 cm wide, broadly oblanceolate, upper surface glabrous, lower surface with dense short hairs, base cuneate or attenuate, margin reddish but reddish purple when young, apex long acuminate, acumen to 4.5 cm long; ligule shortly and unequally bilobed, lobes 2-3 mm long, apex obtuse, reticulate, ciliate; sheath strongly reticulate, scabrid, reddish inside. Inflorescence borne 5-20 cm above ground, 2-9.5 cm long, longer in fruit, to 18 cm long; peduncle 1.5-6 cm long, 2-4 branched at base or unbranched, non-mucilaginous; bracts 2, hairy, sceletonized; bracteoles tubular, 1-1.3 cm long, manicate, only veins remaining above tube after decay. Flowers 1.8-3.8 cm long, densely pubescent with straw colored hairs; calyx membranous, 1.2-1.7 cm long, 0.4-0.6 cm wide, tubular, trilobed, apex acute and shortly apiculate with tufted hairs at tip, outside densely hairy, inside glabrous; corolla tube 1.2-2.4 cm long, both surfaces pubescent but more densely hairy near apex of inner surface; dorsal petal 10-12 mm long, 4-7 mm wide, elliptic, pubescent, hooded, apex obtuse, with long tufted hairs at tip; lateral petals, 9-10 mm long, 3(-5) mm wide, lanceolate, outside densely hairy, ciliate; labellum 12-14 mm long, 7-9 mm wide, obovate, apex emarginate or bilobed for 1-2 mm, base pink, tip pale orange, margin with scarlet transverse lines, with median longitudinal groove, both surfaces sparsely hairy; lateral staminodes linear, 3-5 mm long, 1-2 mm wide, apex acute, longer than stamen filament, curved outwards, glabrous except basally densely tomentose; filament 2-3 mm long, 2 mm wide; anther oblong, 5-8 mm long, 2-3 mm wide, both surfaces densely hairy; anther crest rounded, 3 mm long, 2(-3) mm wide, apex retuse, glabrous; style 2.6-2.7 cm long, with long hairs, more densely so distally, free from corolla wall; stigma 1-1.5 mm wide, with dorsal opening, mouth ciliate; epigynous glands 1.1-2 mm long, 2 mm wide, ovary c. 2 mm long, pubescent, overlapping. Capsule globose to subglobose, sometimes ridged, c. 1.8 cm long, c. 1.2 cm wide, covered with short hairs, green, red near apex when young, immature fruit totally red, turning brown at maturity.

Distribution. Borneo (Sabah).

Habitat. Primary and logged forests, mixed lowland dipterocarp forests, ridge slopes, shady areas under shrubs, mossy forests.

Etymology. The epithet 'roseiflora' denotes the pinkish flowers.

Notes. Sessile leaves are common in *P. rosei-*

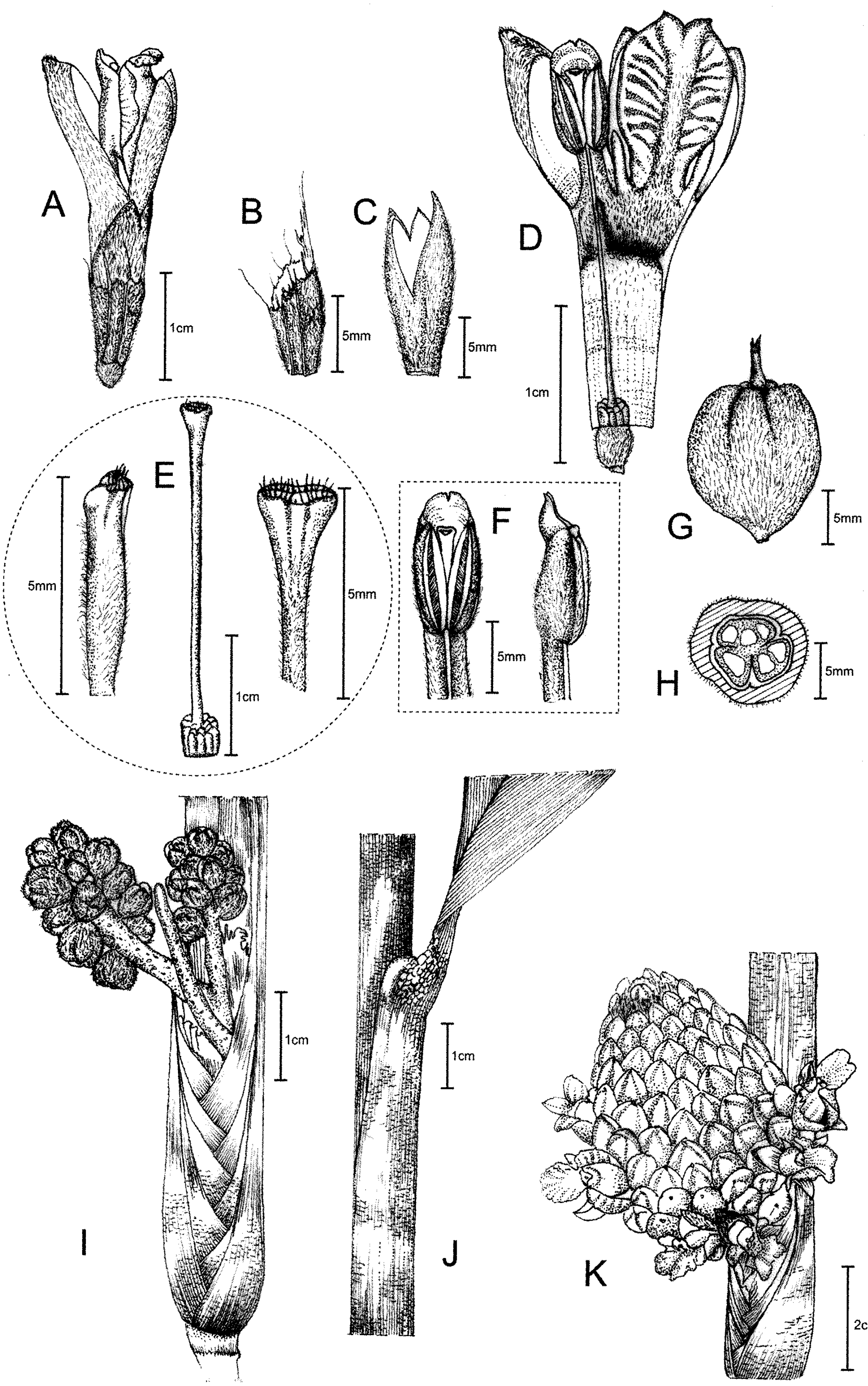

FIG. 4. *Plagiostachys roseiflora* A. Julius & A. Takano. A: Flower. B: Bracteole. C: Calyx. D: Dissected flower. E: Stigma, profile view (left); Stigma, style, epigynous glands (center); Stigma, close-up (right). F: Lateral (right) and front (left) views of anther and anther crest. G: Capsule. H: Cross section of capsule. I: Infructescence. J: Ligule. K: Inflorescence. (Drawn by Jusimin Duaneh).

flora, but some leaves are petiolate, with the petiole to 1.5 cm long, scabrid, pubescent, and swollen laterally at the base (*A. D. Poulsen 1563*, SAN; *D. Magintan 579*, BORH).

Affinity. Plagiostachys roseiflora is similar to *P. megacarpa* in the tubular, pubescent, papery bracteoles, densely hairy flowers, style free from the corolla wall, globose to subglobose capsules, and crested anther. The former, however has the lower surface of the lamina shortly hairy, a much branched inflorescence, trilobed calyx, anther crest rounded and retuse, and glabrous capsules. It is similar to *P. strobilifera* in the lower surface of the leaves pubescent, densely hairy inflorescence, pinkish and pale yellowish orange middle lobe of the labellum, the margin with scarlet transverse lines, style free from the corolla wall and globose capsule. *Plagiostachys roseiflora* can be readily distinguished from *P. strobilifera* by its tubular bracteole that disintegrates just before anthesis, the long bilobed ligule, crested anther, and the calyx not persistent in fruit. In its pinkish flowers, labellum crinkled along the margin, and crested anther, *P. roseiflora* resembles *P. oblanceolata*. The former, however, is readily distinguished by its longer bracteoles, orange tipped labellum, and style free from the corolla wall.

Specimens examined. MALAYSIA. **Sabah:** Kinabatangan District: Gn. Rara Forest Reserve, mixed dipterocarp forest, 4°47'N, 116°54'E, 530 m alt., *Saw FRI40281* (SAN); Imbak Valley, *Dolois et al. SP15505* (SNP). Lahad Datu District: Danum Valley Conservation Area, Orchid Trail, *A. Julius & J. Gisil 2* (BORH), *ibidem*, *A. Julius & A. Takano AT64* (BORH); Orchid Trail to East Trail, 4°40'N, 117°29'E, 150 m alt., 4 Aug. 1998, *D. Magintan 579* (BORH). Ranau District: Poring Hot Spring, Langanan Trail, 870 m alt., *H. Ikeda et al. 0403976* (BORH). Sipitang District: Ulu Padas, along logging road south-west of Long Pasia, in open area near road, 4°21'N, 115°41'E, 1430 m alt., *A. D. Poulsen et al. 1563* (SAN). Tambunan District: Crocker Range Park, Mahua Camp, in secondary forest, 5°48'N 116°24'E, 900 m alt., *A. D. Poulsen et al. 1510* (SAN). Tawau District: Taman Bukit Tawau, Trail Selatan Atas, *A. Julius & S. Limbawong 1* (BORH, SNP), *Duni & Zainuddin SP19052* (SNP); Route to Bt. Galas, *Jamili et al. 3135* (SNP). Tenom District: Ulu Tomoni, Sg. Nagas, primary forest, river bank, 900 m alt., *D. Sumbin et al. SP15231* (SNP).

5. Plagiostachys viridisepala A. Julius & A. Takano, sp. nov. (Figs. 5 & 8)

Plagiostachydi crocydocalyci laminis foliorum inferne confertim pubescentibus, et inflorescentia mucilagina similis, sed a qua anthera conspicue cristata, 2 mm longa, incurvata et apice retusa, labello obovato, floribus flavis praeter calyces virides differt.

Typus. MALAYSIA. Sabah: Kota Belud District, Kinabalu Park-Sayap, 6°10'N 116°34'E, 29 April 2004, *A. Julius 194* (holo- SAN; iso- HYO).

Perennial herbs. Stem leafy, 1.3-3 m tall. Leaves sessile, c. 6 pairs per shoot; lamina c. 120 cm long, 18 cm wide, broadly elliptic, upper surface glabrous, lower surface densely pubescent, base shortly attenuate, margin undulate, apex acuminate, acumen to 2 cm long; ligule 5-17 mm long, deeply bilobed; lobes brittle, slightly reticulate, apex rounded, glabrous; sheaths finely reticulate, glabrous, yellowish green. Inflorescence borne 14-20 cm above ground, 25-27 cm long, ovoid, unbranched, mucilaginous; bracts 0; bracteoles tubular, tube portion c. 7 mm long, only veins remaining above the tube after decay, later splitting to base, inside glabrous, outside lanulose. Flowers 2.5-2.7 cm long, yellow; calyx fleshy, c. 8 mm long, tubular, decaying to leave only veins in upper half, outside manicate, green; corolla tube c. 7 mm long, inside glabrous, outside densely hairy; dorsal petal c. 11 mm long, 5 mm wide, hooded, apex acute, with short densely tufted hairs, inside glabrous, outside densely hairy, ciliate; lateral petals c. 10 mm long, 4 mm wide, elliptic, outside densely hairy; labellum c. 13 mm long, 10 mm wide, obovate, apex with 2 lateral clefts, margin distally slightly undulate, lower surface with long scattered hairs, upper surface glabrous, pale yellow; lateral staminodes c. 2 mm long, triangular, with swelling at base, yellow, glabrous; anther c. 7 mm long, 3.5 mm wide, pale

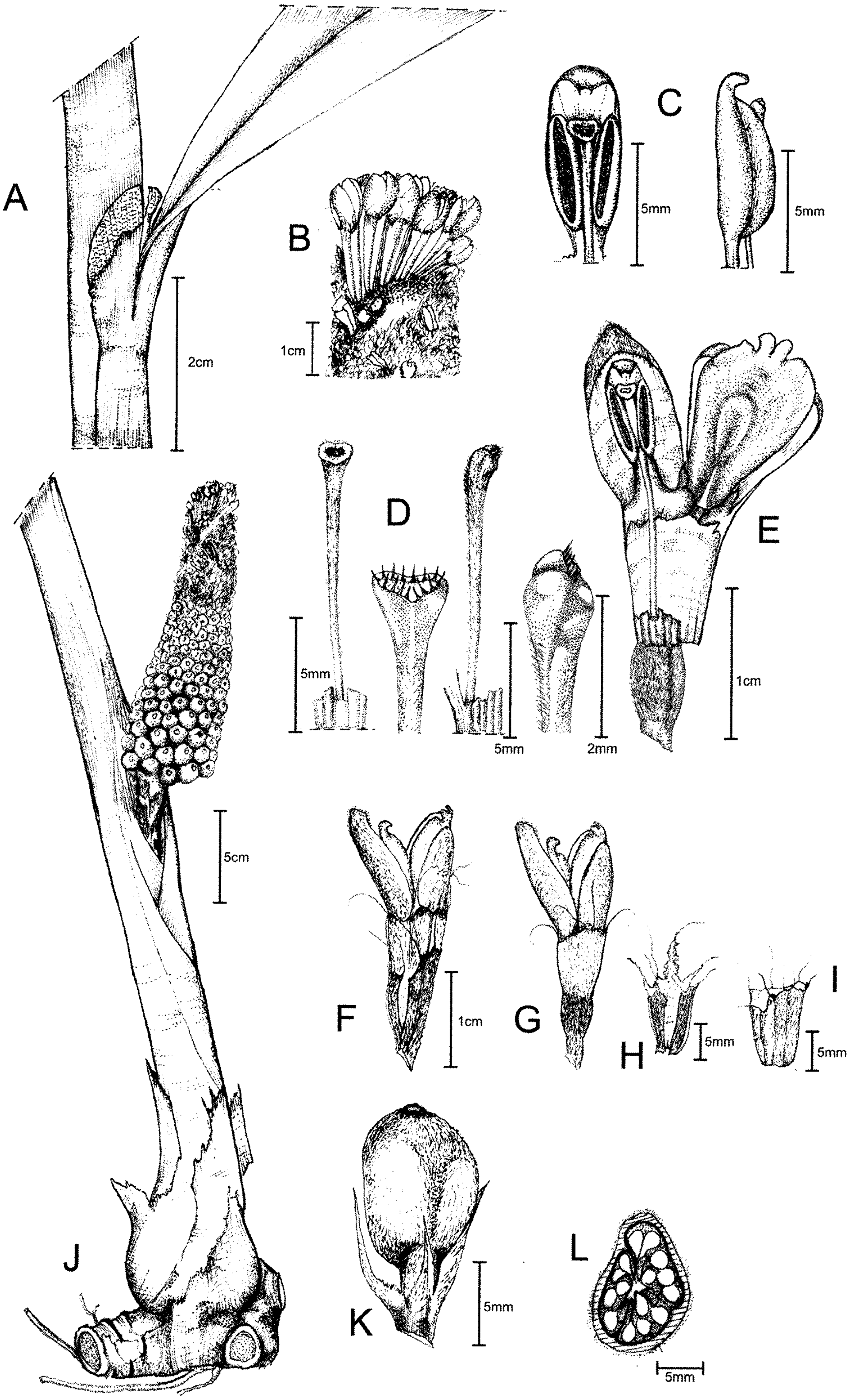

FIG. 5. *Plagiostachys viridisepala* A. Julius & A. Takano. A: Ligule. B: Close-up of flower buds. C: Lateral (right) and front (left) views of anther and anther crest. D: Stigma, style, and epigynous glands (left); Stigma, close-up (second left); Stigma, style and epigynous glands, profile view (second right); Stigma, profile view (right). E: Dissected flower. F: Flower with bracteole. G: Flower without bracteole. H: Bracteole. I: Calyx. J: Inflorescence and infructescence. K: Capsule. L: Cross section of capsule. (Drawn by Jusimin Duaneh).

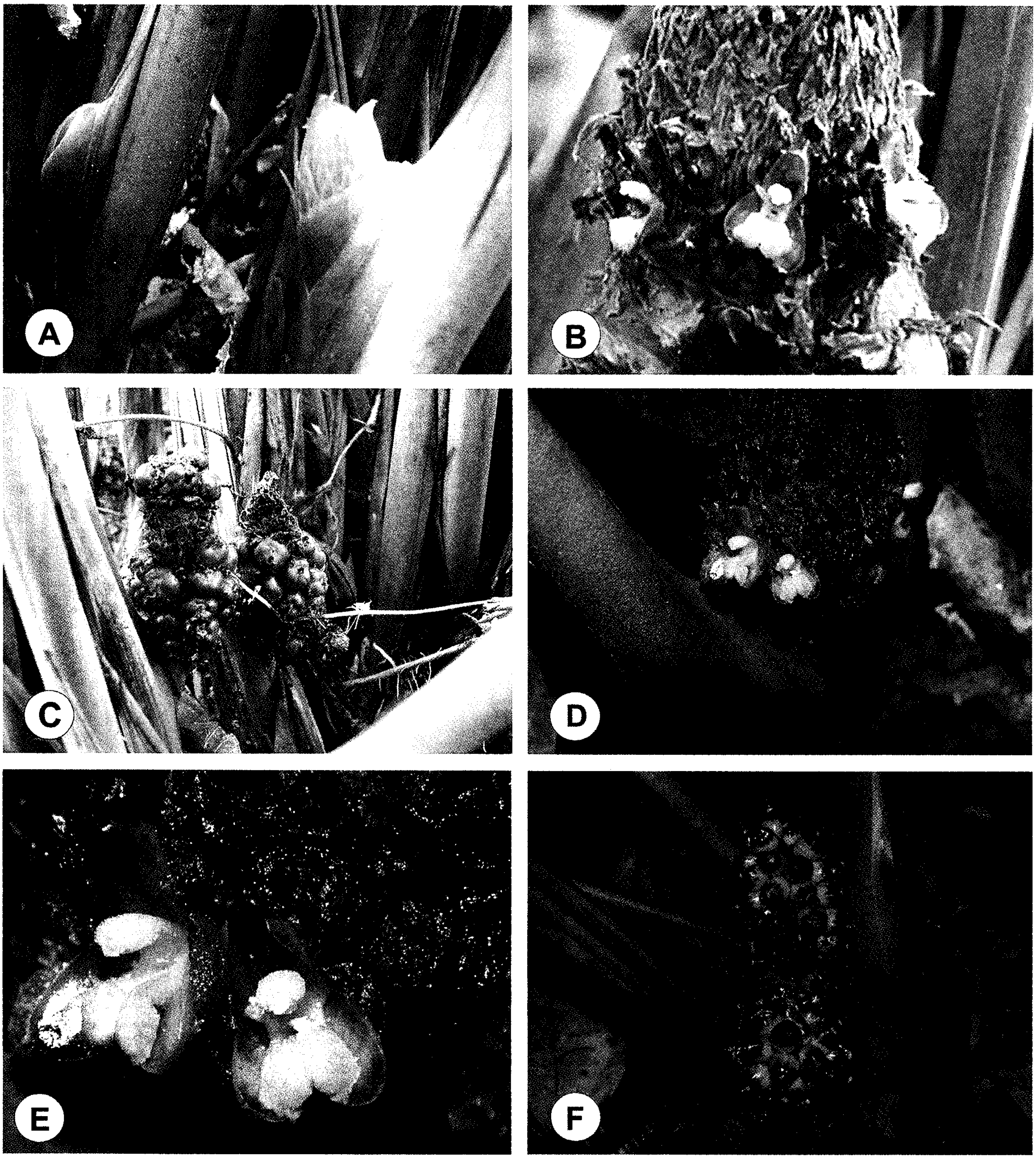

FIG. 6. (A-C) *Plagiostachys brevicalcarata*. A: Inflorescence in bud. B: Inflorescence with few open flowers at base. C: Infructescence, showing immature (red) and mature (green) fruits. (D-F) *P. longicaudata*. D: Inflorescence. E: Flowers. F: Infructescence (Photos A-C by A. Julius and D-F by A. Takano).

green, with pale yellow thecae, splitting longitudinally, glabrous; anther crest c. 2 mm long, incurved, apex shallowly bilobed, rounded, sometimes with 2 or 3 fimbrils at tip of lobes; filament to 2 mm long, glabrous; style c. 13 mm long, free from corolla wall, densely hairy abaxially and adaxially on upper half, with scattered hairs on lower part; stigma bilobed, with dorsal opening, mouth fimbriate; epigynous glands c. 3 mm long, yellow, glabrous; ovary globose, sericeous. Capsules 12-15 mm long, 12

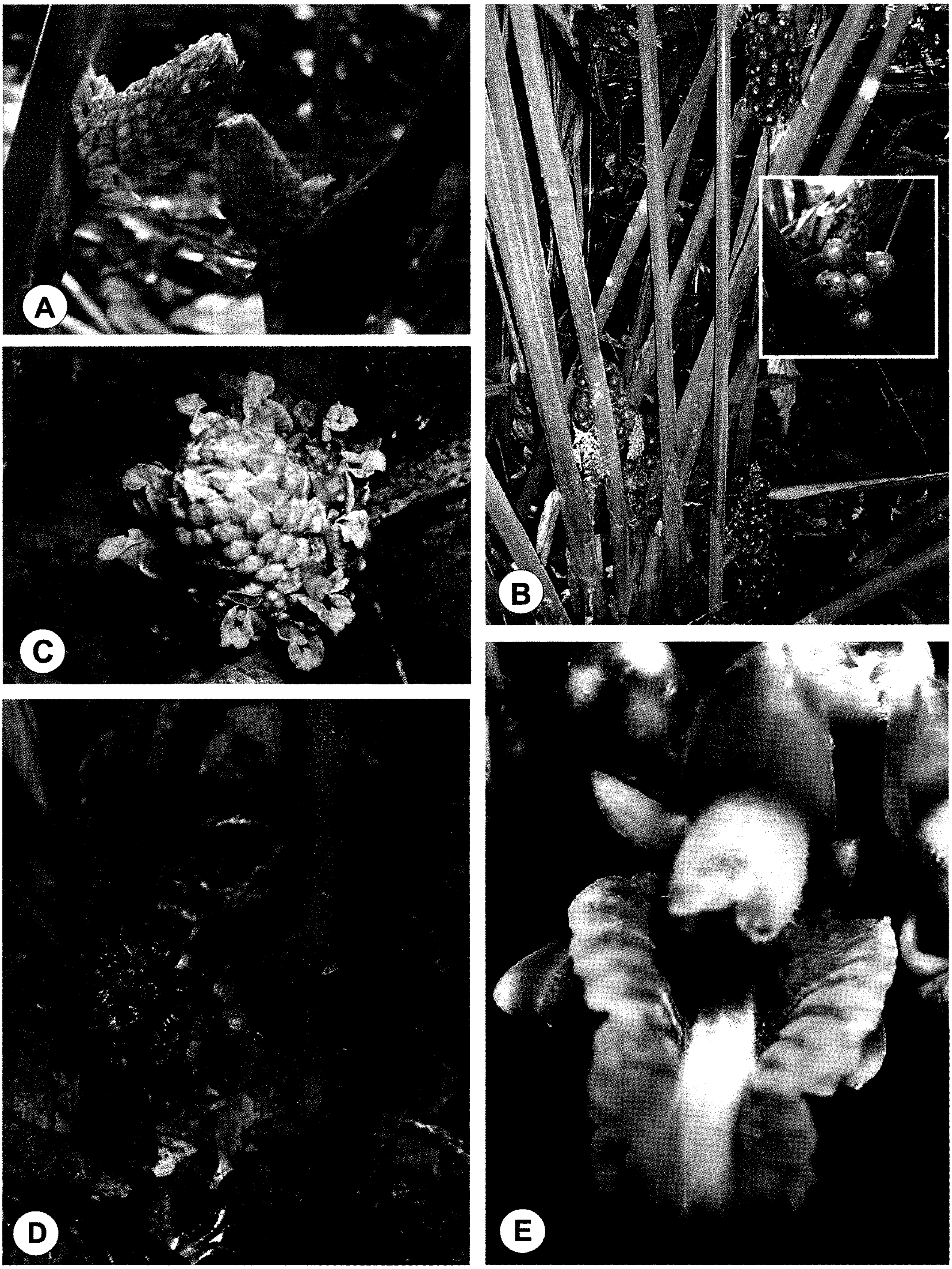

FIG. 7. (A-B) *Plagiostachys megacarpa*. A: Inflorescence, showing few open flowers at base. B: Infructescence, showing mature and immature fruits (inserted picture). (C-E) *P. roseiflora*. C: Inflorescence. D: Infructescence. E: Flower (Photos A & B by A. Julius, C & E by D. Malidin, and D by A. Takano).

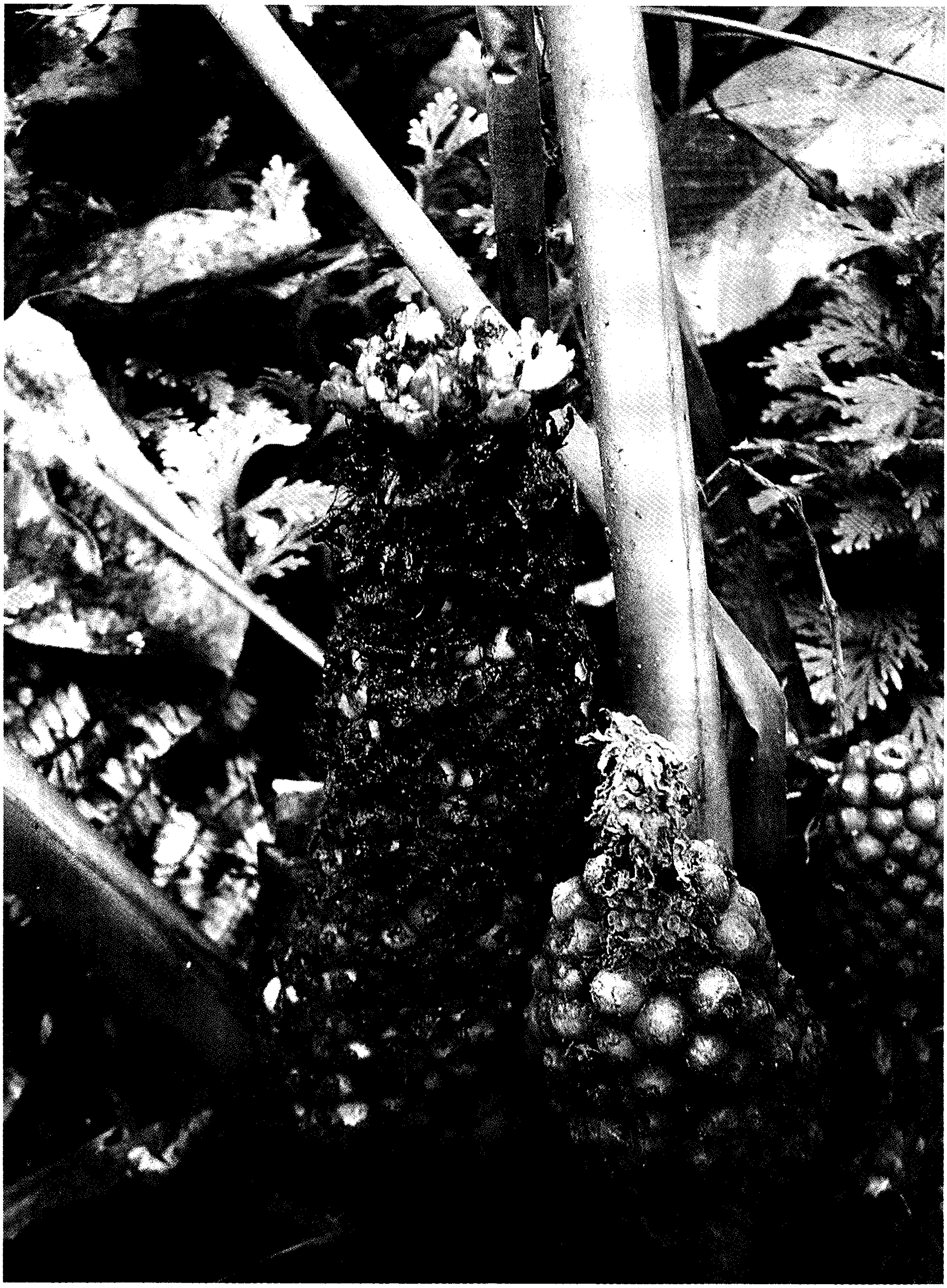

FIG. 8. *Plagiostachys viridisepala*, showing few flowers opening at apex of the infructescence (Photo by A. Julius).

mm wide, subglobose, crowned by short decayed calyx, pedicel to 5 mm long, hairy, yellowish green when immature, turning yellow at maturity, wrinkled and brown when dry, densely hairy particularly at apex and base.

Distribution. Borneo (Sabah, Sawarak, and E Kalimantan)

Habitat. *Plagiostachys viridisepala* occurs in primary and old secondary lowland to submontane (350-1185 m) forests, shady and cool areas in forest gaps, sometimes near the banks of small streams, and also in places with thick litter and dead branches where trees have fallen.

Etymology. The specific epithet refers to the color of the sepals, which are distinct from in the genus.

Vernacular name. Unong (Iban). The ripe fruits are edible.

Affinity. The yellowish green petals and pale yellow, obovate labellum characterize *P. viridisepala*. It is similar to *P. crocydocalyx* in the mucilaginous inflorescence, large leaves, large and long infructescence, bilobed and brittle ligule, and globose and pubescent capsule. *Plagiostachys viridisepala* has an incurved, retuse anther crest of 2 mm long, an obovate labellum with long scattered hairs on the lower surface, filaments to 2 mm long, and a corolla tube to 7 mm long. These features are different from those of *P. crocydocalyx*. In well prepared, mature herbarium specimens, the two species can be distinguished by capsule size.

Specimens examined. MALAYSIA. **Sabah:** Kota Belud District: Kinabalu Park-Sayap, near Kemantis Trail, 6°10'N 116°34'E, 1000 m alt., *A. D. Poulsen & V. Jamnicky 1587* (SNP); Penigupan Tahubang, outside park boundary, lower montane forest, 1120 m alt., *D. Malidin et al. SP11237* (SNP). Penampang District: Moyog, Crocker Range, Sunsuron road, 200 ft, *A. Lamb & A. Phillipps ALED303/91* (E). Tambunan District: Km 42, Tambunan to Kota Kinabalu road, private land, old secondary forest, *A. Julius & Sik R. Y. 1* (BORH). Sarawak: Kapit, Muyong, Sg. Amau, Hose Mountain, submontane forest, valley at stream bank, 1180 m alt., *Lai et al. S64115* (SAR); 7th Division, Bario Highlands, *A. D. Poulsen 1869* (SAR).

INDONESIA. **East Kalimantan**: Kayan Mantarang National Park, along trail en-route from Sub-Camp 1 to Sub-Camp 2, *J. Gisil 561* (BORH).

Key to Bornean *Plagiostachys*

1a. Ovary glabrous ………… 2

  2a. Inflorescence mucilaginous; calyx and bracteole fleshy and decaying ………… 3

    3a. Labellum whitish yellow with pink venation along margins ………… **P. albiflora**

    3b. Labellum plain yellow, without such a venation ………… 4

      4a. Capsule bicolored, basal part green, apex dark purple; dorsal petal hooded, with a spur, shortly obtuse; leaf apex long caudate, c. 4 cm long ………… **P. longicaudata**

      4b. Capsule of one color, green, yellow, purplish red or dull green; dorsal petal hooded, apex acute; leaf apex acuminate, c. 3 cm long ………… 5

        5a. Anther crested ………… **P. brevicalcarata**

        5b. Anther ecristate ………… **P. glandulosa**

  2b. Inflorescence non-mucilaginous; calyx and bracteoles papery, sometimes disintegrating before anthesis ………… **P. breviramosa**

1b.Ovary pubescent ………… 6

  6a. Inflorescence mucilaginous ………… 7

    7a. Flowers to 5 cm long; anther c. 10 mm long, ecristate; labellum broadly oblong, whitish yellow, margin crenulate ………… **P. crocydocalyx**

    7b. Flowers c. 2.7 cm long; anther c. 7 mm long, anther crest c. 2 mm long; labellum obovate, yellow ………… **P. viridisepala**

6b. Inflorescence non-mucilaginous ········ 8
  8a. Bracteoles opens to base, distinctly apiculate, 3-5 mm long ········ **P. bracteolata**
  8b. Bracteoles totally tubular or tubular at base and free apically, apex do not apiculate ········ 9
    9a. Style adnate to corolla wall ········ 10
      10a. Leaf base cuneate; anther crest entire; staminodes oblong ········ 11
        11a. Both surfaces of leaves pubescent; labellum ovate ········ **P. lasiophylla**
        11b. Upper surface of leaves glabrous, lower surface pubescent; labellum elliptic ········ **P. oblanceolata**
      10b. Leaf base unequally cordate; anther crest deeply bilobed; staminodes spatulate··· **P. parva**
    9b. Style free from the corolla wall ········ 12
      12a. Anther ecristate ········ **P. strobilifera**
      12b. Anther crested ········ 13
        13a. Bracteoles tubular at base, free apically ········ **P. sp.** (aff. *strobilifera*) of Smith (1985: 271)
        13b. Bracteoles tubular ········ 14
          14a. Branches of inflorescence 2-5; capsule subglobose, c. 1.8 × 1.2 cm, apex green tinted red when young, brown at maturity; calyx trilobed ········ **P. roseiflora**
          14b. Branches of inflorescence 2, rarely 3; capsule globose, to 3.5 × 2 cm, dull green when young, dark brown at maturity; calyx bilobed ········ **P. megacarpa**

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